APPENDIX A

Let:

n_1 = real index of refraction of air

n_2 = real index of refraction of photoresist

n_3 = real index of refraction of ARL

n_4 = real index of refraction of substrate

k_1 = imaginary index of refraction of air

k_2 = imaginary index of refraction of photoresist

k_3 = imaginary index of refraction of ARL

k_4 = imaginary index of refraction of substrate

t = ARL thickness

m = odd integer

λ = wavelength of incident radiation

I_3 = intensity of beam #3

I_5 = intensity of beam #5

I_1 = intensity of beam #1

T_{12} = transmittance from air to photoresist

R_{23} = reflectance from ARL in photoresist

a_2 = absorption factor in photoresist

T_{23} = transmittance from photoresist to ARL

a_3 = absorption factor in ARL

R_{34} = reflectance from substrate in ARL

$\Delta\varnothing$ = change in phase angle

Using equations (1) and (2):

$$n_3 \cdot 2t = \tfrac{1}{2}(m\lambda) \qquad m = 3\ (540°) \qquad (1)$$

for $|n_2| < |n_3| < |n_4|$

$$I_3 = I_5 \tag{2}$$

$$I_3 = I_1 \cdot T_{12} \cdot R_{23} \cdot a_2$$

$$I_5 = I_1 \cdot T_{12} \cdot a_2 \cdot T_{23} \cdot a_3 \cdot R_{34} \cdot a_3 \cdot T_{23}$$

Therefore, because $I_3 = I_5$

$$R_{23} = T_{23} \cdot a_3 \cdot R_{34} \cdot a_3 \cdot T_{23}$$

$$R_{23} = (T_{23})^2 \cdot (a_3)^2 \cdot R_{34}$$

These operations can be satisfied for n_2, n_3, n_4, t, λ, k_2, k_3, and k_4 where

$$R_{23} = \frac{(n_2 - n_3)^2 + (k_2 - k_3)^2}{(n_2 + n_3)^2 + (k_2 + k_3)^2}$$

$$T_{23} = 1 - R_{23}$$

$$R_{34} = \frac{(n_3 - n_4)^2 + (k_3 - k_4)^2}{(n_3 + n_4)^2 + (k_3 + k_4)^2}$$

$$(a_3)^2 = \exp - 2\ \frac{(2nk_3 \cdot 2t)}{\lambda}$$

For 248 nm with A1 substrate, $n_2 = 1.8$, $k_2 = 0.011$

ARL $n_3 = 2.3$, $k_3 = 0.33$, $\tau = 700 - 850$ Å

$A\ell$ - Si $n_4 = 0.089$, $k_4 = 2.354$

$$R_{23} = 0.0197$$

$$(T_{23})^2 = 0.961$$

$$R_{34} = 0.714$$

$$(a_3)^2 = 0.0814$$

$$R_{23} = 0.0197$$

$$(T_{23})^2 \cdot (a_3)^2 R_{34} \doteq 0.0559$$